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The Monetary Cost of the Non-Use of Renewable Energies

– Update 2017 –

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Abstract

It is often claimed that renewables are not yet competitive with most conventional energy sources. But what costs are incurred when renewable energies are *not* used? The unused solar and wind energy potential of today is lost forever tomorrow. Every day during which potential renewable energy sources are not utilised but exhaustible fossil fuels burnt instead speeds up the depletion of these non-renewable fuels. Using burnt fossil fuels for non-energy related purposes (e.g. in the petrochemical industry) in the future is obviously impossible. Thus, their burning – whenever they could have been replaced by renewables – is costly capital destruction. In contrast a non-energetic use could maintain the value of the fossil raw materials e.g. through an application in a circular flow economy.

The goal of this study is to provide a realistic estimate of the costs resulting from this non-use of renewable energies. It updates the initial study (2012) with data from 2011 to 2015. It concludes that the future usage loss resulting from our current oil, gas and coal consumption amounts to 3.7 trillion US-Dollar per year.[1]

[1] Throughout this paper the American numerical scale (rather than British English) will be used.

Explanatory note for the 2017 update

Five years ago, the World Future Council published the first study measuring the losses incurred when finite fossil fuels instead of available renewable energies are used for energy production. The core method used is to calculate the value – as reflected by their price - of these fossil raw materials lost to a future non-energetic consumption. In order to minimize the effects of price fluctuations, an average reference price was established for the period 2006 to 2010. The current study is based on the data for the next five-year period (2011-2015). The advantage of this method is that neither the (unknown) future energy prices have to be estimated, nor do the environmental effects of climate change have to be monetarized. Each tonne or cubic meter of fossil raw materials, once burned, is permanently lost for use as the basis for many (petrochemical) manufacturing processes. The absence of these raw materials therefore also entails financial losses, which are reflected in the market prices of these raw materials. Such losses can be avoided by using renewable energies instead.

The proportions of non-energetic use and the reference prices determined (and partly estimated) have been kept constant, as the aim is to highlight the loss of finite resources, not the volatility of energy prices.

Introduction

Previous studies to assess the costs of the non-use of renewable energies consist mostly of attempts to ascertain the costs arising from expected climate damage caused by burning fossil fuels. By internalising these costs the apparent competitive advantage of fossil fuels often disappears. More challenging is the question of how to monetise future damages,[2] with previous studies often criticised for their methodology.[3] This study raises a different, hitherto ignored issue. Externalised costs from burning fossil fuels are incurred not only through damages from climate change but also through the lack of future availability of fossil raw materials consumed to meet our current energy demands, although alternatives exist. This study is a first attempt to calculate the costs of this loss.

1. Framing the problem

The sun and the winds are free. Thus, the costs of renewable energy are almost exclusively fixed extraction costs, whilst the use of fossil fuels incurs significant variable costs (reflecting the value of the fuels burnt). The difference between renewables and fossil fuels is not only the zero cost of renewables but also that they will never be exhausted.

How can the value of a commodity be measure, whose usage is free and inexhaustible? This can only be done indirectly through calculating the costs incurred when the use of a free and never-ending commodity

[2] The breadth of studies ascertaining the external costs of human-induced CO2 emissions ranges from 14 to 300 Euro per ton CO2. See „Agentur für Erneuerbare Energien (Hrsg.); Kosten und Preise für Strom, Fossile, Atomstrom und Erneuerbare Energien im Vergleich“, Renews Spezial, Edition 52, September 2011, p. 28

[3] See e.g. the discussions around the Stern Report: Stern, N.; Stern Review on the Economics of Climate Change, London 2006

is supplanted by the use of a finite commodity, which is destroyed, and thus unusable in the future, through its one-time use as energy. In contrast, it is the wind which blows and sun which shines but is not used today which is lost forever.

The renewable energy not used today thus cannot replace fossil fuel raw materials that, having been burnt as energy, are lost forever. This means that the use these raw materials *could* have had in the future is lost and additional costs will be incurred to replace them.

To calculate the loss incurred, the alternative use value of the burnt fossil fuels must be estimated.
It is increasingly clear that, by remodelling our energy-systems, fossil fuels can be substituted by renewables. Every entity of fossil raw material that can be replaced by renewable energy retains its value as a raw material to be used in the future for non-energetic uses. For the energetic use of fossil raw material there is the alternative of using renewable energies, whose current usage, unlike that of e.g. oil, does not exclude further usage.
The lost value of under- or unutilised renewable energy therefore consists of the future lost value of burnt fossil fuel raw material, which is no longer available for non-energetic uses. The aim of this introductory study is not to make a full cost comparison between current renewable energies and fossil fuels in which all external benefits of renewable energies are internalised. Our aim is only to estimate the future lost usage value of burnt fossil raw materials in order to be able to establish the costs of the current under-usage of available renewable energy potential.

2. The methodology to measure non-usage

The burning of finite fossil resources for energy consumption forfeits their usage in the future. As costs equal benefits in a market economy, the costs equal the monetary losses that are created through future usage loss.

The usage of a commodity must be at least as high as the costs of procuring the commodity otherwise it would not have been bought. In the real market economy this value is usually higher than the cost as only then can the buyer make a profit. Calculating by how much the usage value exceeds the cost is methodologically very difficult, so this study uses the conservative assumption that the usage value is at least as high as the price of procurement.

What is the price of the fossil raw materials used for non-energetic production? The standard global market prices of oil, gas and coal can be referred to as these are usually similar for energy and other product usages. The future value of fossil raw materials which could be (but are currently not) used for non-energy production purposes can be estimated by looking at the percentages of energetic and non-energetic use of different fossil raw materials. But current data on global non-energetic uses cannot be extrapolated into the future. Many less industrialised countries use fossil raw materials exclusively for energy as they do not have industries which can utilise these materials for other purposes. Therefore, an extrapolation of current figures would severely underestimate the costs incurred by unnecessarily burning fossil fuels now, as future demand (and thus prices) for fossil raw materials for non-energy uses are likely to become much higher, as more countries industrialise.

A reference price deriving from the five-year average of the observation period was proposed for the initial study. Since the actual benefit loss is a loss of the quantity of burned fossil fuels and not of current energy prices, this study is based on the consumed quantities of fossil raw materials, assessed at the reference price determined in the initial study.

The non-energetic use

To estimate the probable global demand and the prices of fossil raw materials for non-energetic uses in the future, the current demand and prices of an industrialised country should therefore be taken as a reference model. Our estimates for rating non-energy use percentages of fossil raw materials are based on Germany, as a representative industrial country. We assume that the long-term global demand for commodities created from fossil raw materials will be similar to those of a mature industrialised country. As a reference model for future global usage-rates of fossil raw materials for non-energetic uses we therefore extrapolate current German usage-rates globally.

3. The valuation model

3.1. Establishing the non-energetic consumption in the reference model country

According to the data of the AG Energy Balance[4] the non-energy usage consumption in Germany in 2009 was:

- 765,224 TJ[5] of crude oil
- 144,095 TJ of natural gas
- 10,318 TJ of hard coal[6]

Relative to the total usage of:

- 5,673,584 TJ of crude oil
- 3,508,024 TJ of natural gas
- 1,537,591 TJ of hard coal

Resulting in a rate of non-energy usage consumption of:

- 13.5 % of crude oil
- 4.1 % of natural gas
- 0.7 % of hard coal

[4] AG Energiebilanzen e.V. (AGEB), Energieflussbild Deutschland 2009 (Detail in TJ), rate as of 31.03.2011.

[5] TJ = Terrajoule

[6] In this study only the value of hard coal will be considered, as there is no real market price for brown coal which could be used. There is no world market price for brown coal, as it is not internationally traded but rather used in proximity to the mine. Bundesministerium für Wirtschaft und Technologie, Arbeitsgruppe Energierohstoffe, Kurzbericht: Verfügbarkeit und Versorgung mit Energierohstoffen, 29.03.2006. The overall result is only marginally influenced by omitting the assessment of brown coal.

3.2. The Estimation of global non-energy consumption for the updated period (2011-2015) based on the reference price

First, the global consumption and extraction of the respective fossil raw materials must be determined. In order to smooth the annual fluctuations, the 2011-2015 average is used.

The annual global consumption of **oil**[7] over the years 2011-2015 averaged:

4,113 million tonnes

(2006-2010: 3.977 million tonnes)

The annual global consumption of **natural gas**[8] between 2011-2015 averaged:

3,190 billion cubic meters (m3)

(2006-2010: 2,987 billion m3)

The annual global production of **hard coal**[9] 2011-2015 averaged:

6,940 million tonnes

(2006-2010: 5,704 million tonnes)
Based on the share of non-energy use in the reference country, we calculate a global annual requirement for non-energy uses of:

- 555 (537) million tonnes of oil

- 131 (122) billion m3 of natural gas

- 49 (40) million tonnes of hard coal

Valuation of the non-energy use of the raw materials at the average price of the reference period

In order to determine the value of the fossil raw materials lost for non-energy use, the average annual reference price in the first study is used. The prices determined are constant because the aim is to focus on the material quantity changes. It can be assumed that the demand for fossil fuel raw materials for non-energetic uses reacts very in-elastically to price changes, because the fossil raw material is only a small part of the end product. A price change would thus have very little effect on the use of fossil raw materials for non-energy purposes.

For crude oil this equates to US $ 75.2 per barrel[10], for natural gas US $ 8.79 per million Btu[11] and for hard coal US $ 83.6 per ton.[12]

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[7] BP, BP Statistical Review of World Energy, June 2016, p. 11

[8] BP, p. 23

[9] EIA, U.S. Energy Information Administration, International Energy Statistics (http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=1&pid=9&aid=1&cid=ww,&syid=2006&eyid=2010&unit=TST) and: Statista.com: https://www.statista.com/statistics/267578/production-of-hard-coal-worldwide-since-1993/

Thus, the value of the oil, natural gas and hard coal used for non-energy production totals:

- Oil: US $ 332 billion
- Natural gas: US $ 43.6 billion
- Hard coal: US $ 4.1 billion

In total, this represents a value for the non-energy use of these fossil raw materials of: US $ 378 billion annually. The benefit lost annually, when equivalent fossil fuel raw materials are destroyed by a one-time energy use corresponds to this value. Therefore, the non-substitution of these fossil fuels by regenerative energy results in a loss (or natural capital destruction) of US $ 378 billion annually.

3.3. The assessment of the total alternative usage value loss caused by the one-time usage of fossil raw materials for energy production

These calculations relate only to the lost opportunity cost of the annual non-energy use of fossil fuels. With a relation between energy to non-energy usage of e.g. 10 to 1, in one year ten times the possible consumption for non-energy purposes is destroyed. The loss of usage thus stretches far into the future. Using current market prices the total usage loss can be estimated by subtracting the non-energy consumption from the total consumption of fossil raw material.

The total consumption of **oil** averaged over the years 2011-2015 (2006-2010):

4,113 (3,977) million tonnes or 32,668 (29,032) million barrels of oil.

At the reference price (2006-2010 average) of US $ 75.2 per barrel, the annual total is US $ 2,457 (2,183) billion.

The total consumption of **natural gas** averaged 2011-2015 (2006-2010):

3,190 (2,987) billion m3, and BTU 120,8 (113,1) billion respectively.

At a reference price (2006-2010 average) of US $ 8.79 per million BTU, the total value was US $ 1062 (994) billion.

The annual production of **hard coal** in 2011-2015 averaged 6940 (5,704) million tonnes.
At an average price of US $ 83.6 (2006-2010 average), the total value was US $ 580 (477) billion.

[10] BP, p. 15

[11] BP, p. 27

[12] BP, p. 30. The value was calculated from the unweighted average of coal prices for Northwest Europe marker price and from the US Central Appalachian coal spot price index.

Based on the above calculations for non-energy use, we arrive at:

Oil:
2,457 - 332 = US $ 2,125 billion

Natural gas:
1,062 - 44 = US $ 1,018 billion

Hard Coal:
580 - 4.1 = US $ 575.9 billion

Thus the total usage loss in 2011-2015 can be estimated at:

2.125 + 1.018 + 576 = US $ 3.719 billion

(2006-2010 US $ 3.221 billion)

4. Conclusion

The total future usage loss caused by the current energy use of oil, gas and coal in one year, based on the average market prices, can therefore be calculated at ca. **US $ 3.7 trillion.** Those who object that the average prices for oil and hard coal have fallen compared with the first reference period should note that the total quantities of oil, gas and hard coal burnt / consumed all increased, thus decreasing future availability of these finite resources.

Preserving increasingly valuable fossil raw materials for future use is possible by maximizing the use of renewables for energy production. Every day that this is delayed and fossil raw materials are burnt as one-time energy causes a future usage loss of ca. **US $ 10 billion**. An honest cost-comparison of non-renewable and renewable energies needs to also include these costs of *not* using renewables.

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